IB Phil. of Science — Transparencies (1)

1. What is Philosophy
2. Four branches
3. Knowledge v. belief — Sources of Knowledge
4. Views on Science
1a. Observation > Theory — Theory Explanation (see Lewis Section)
1b. A Simple Picture of Science
1. Sense Experience > Knowledge
1c Deduction Science, Common Sense
1d Hume on Cause
2. Hume — Constant Conjunction — Mill def^n of cause
3. Causation > Counterfactuals.
3a. Simple Model of Science (Explanation, Prediction)
4. Types of Scientific Law
5. Human view of Laws
6. Reasons v. Explanations. 6A.) Ramsey-Lewis account.
7. Types of Explanation
8. Deductive explanations of Laws
9. Enumerative induction
10. Eliminative induction.
10a Solutions to the problem of induction
(a) Uniformity of Nature
(b) Pragmatic Justification
(c) Peirce's Solution

P.T.O.

13.) Mill's Method — Joint Residues Concomitant Variation (13a) Agreement Difference (13.2)

14.) Problems with Mill's Methods

Irrelevant factors
Hidden factors
Plurality of Causes
Complexity of Causes.

12.15.) Paradoxes of Confirmation Theory

The Raven Paradox.
The Grue Paradox.
Transitivity Paradoxes

15.) Valid argument
16.) Re logical particles

16 cont.) Symbol
17.) Sound argument
17 cont'd) logical truth
logical contradictions and
18.) The Four views on logic
19.) Language Terms, Sentences
20.) Interpretation, Completeness, Soundness

21 Statements & Judgement
+ analytic proposition

22 Synthetic / analytic distinction

~~and the synthetic a priori~~

23 · Synthetic a priori.

24 Duhem Duno Poris

Lakatos Ed & D-4 Theses.

25

26 Crucial experiments

27 Re history of logic
- Mathematical logic

28

29 Re Syllogism.

30 Syllogism — Moods & Figures

31 Rooks.

32 33 34 35 Examples:

ITO

3.6 Truth Tables or, and, not

3.7 Tautology Ex

3.8 Material implication
If P then Q, Truth Table

3.9 Deduction Theorem

Ex decision procedure for arguments

Methodologies

1. Levels of factual knowledge
2. Falsification
3. Basic statements, falsifiers
4. Popperian criteria, schema
5. Verisimilitude
6.
7.
8. Kuhn on progress of science
9. Incommensurable world views
10. Lakatos
11. Feyerabend

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Transparencies

WHAT IS PHILOSOPHY

Deals with ultimate Reality:
The analysis of concepts, principles and presuppositions underlying any branch of knowledge.

Natural P. Study of objects and phenomena in the physical world.

Moral P. Study of principles of human action or conduct.

FOUR BRANCHES

ONTOLOGY

What there is (i.e. exists)

Tables, chairs, electrons, quarks, colours, numbers, minds, squareness, beauty, God....

EPISTEMOLOGY

How do we know what there is? (and how it behaves etc)

LOGIC

How do we argue about what there is?

ETHICS and AESTHETICS

How do we evaluate what there is?

Good and bad (actions)
Beautiful and ugly (objects etc.)

KNOWLEDGE v. BELIEF

I know X

1) X is true
2.) I believe X
3.) My belief is based on adequate evidence
4.) If X were not true I would not believe X.

SOURCES OF KNOWLEDGE

Reason
sense experience
authority
Intuition
Revelation
Faith

VIEWS ON SCIENCE

ORTHODOX

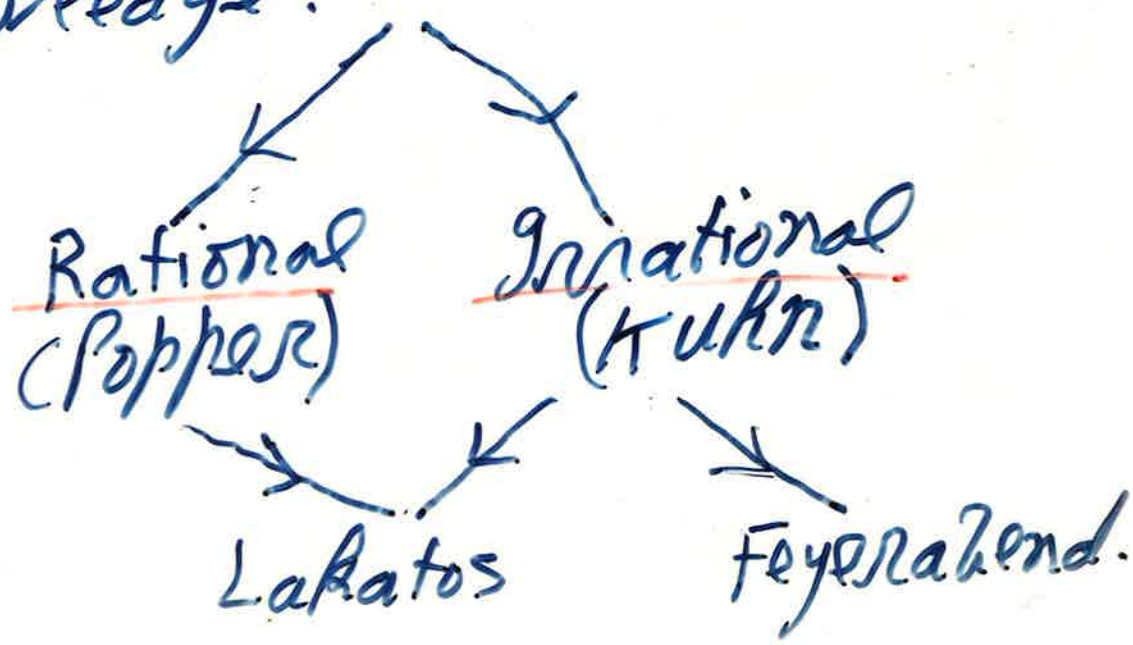
Science gives certain or at any rate probable knowledge

→ Inductivists

– Bucket approach.

UNORTHODOX

Science gives uncertain, problematic or conjectural knowledge.



Distinction between Science and Common sense (C.S.)

1) C.S. not concerned with explanations

2) C.S. makes too extravagant claims

3) C.S. may be inconsistent

4) C.S. tends to survive longer than science

5) C.S. concerned with matters of practical importance.

HUME ON CAUSE

3 conditions:

1) Contiguity
2) Succession
3) constant conjunction

what about necessary connection?

Theories re (3)

a) constant conjunction may not signal causation
ex traffic lights, night and day

b) causation may not imply constant conjunction
ex striking the match may not always result in an explosion

INUS condition

An insufficient but necessary part of an unnecessary but sufficient condition.

Mill's Definition of Cause

Total set of conditions sufficient invariably to produce the effect

Causation and Counterfactuals

If P <u>were</u> the case Q
would be the case

If P were <u>not</u> the case Q
would <u>not</u> be the case.

Then we can say
P causes Q

Problems:
Asymmetry
over determination
preemption

Simple Model of Science (4)

Science is collection of Causal laws of the form

P causes Q

Scientific Explanation of Q is to affirm P causes Q and that P has occurred.

Scientific Method

Rules for arriving at P for any given Q.

Types of Scientific Law

1) Properties attributed to 'Natural kinds'

2) Invariable sequential order
   a) non-causal
   b) causal.

3. Statistical laws

4. Laws of functional dependance.

   Ex Boyle's law $PV = \text{const.}$

   Dynamical laws

   $s = \frac{1}{2} g t^2$.

Humean view of Laws

Cosmic uniformities

1) Universally quantified over all particular instances
2) True
3) Contingent
4) Contains only general predicates

Query Is a river of Coca-Cola physically possible?

Laws as descriptive v. prescriptive

Subjunctive conditionals

Vacuously true laws

Limited laws ex Newton I

ex Kepler's Laws

RAMSEY–LEWIS ACCOUNT

A Humean Uniformity is a law of Nature if and only if it appears as a theorem (or axiom) in a true deductive system that achieves an optimum combination of simplicity and strength.

REASONS VERSUS EXPLANATIONS

The Earth is Round:

Why?

a) Why do you believe the earth is round?

Answer is a <u>reason</u> for your belief

b) Why <u>is</u> the earth round?

Answer is an <u>explanation</u>

TYPES OF EXPLANATION

1.) Deductive - Nomological (D-N)
Model for explaining:
(a) a particular fact
(b) a law

2.) Probalistic explanations

3) Functional or teleological explanation
(cf The Anthropic Principle)

4.) Genetic explanations

EXPLANATION AND PREDICTION

Barometers and flagpoles
Earthquakes.

Deductive Explanations

1) The issue of circularity:
The explanandum should not be the only evidence for the explanans.

2) several laws involved in the explanans

3) Depth and Unification

Enumerative Induction

$$p_n = F_n \times F_{n-1} \times \cdots F_1 \times p_0$$

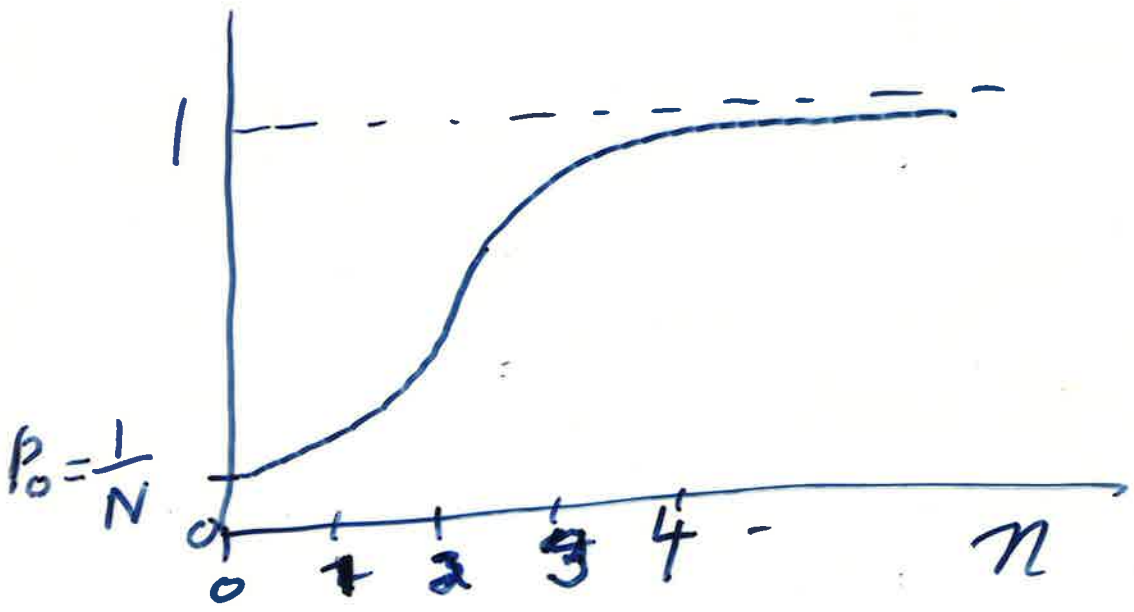
Thus: $p(h \& e) = p(h/e) \cdot p(e) = p(e/h) \cdot p(h)$

But if $h \to e$, then $p(e/h) = 1$, so

$$p(h/e) = \frac{p(h)}{p(e)} \qquad \text{(Bayes' Theorem)}$$

But $p(e) = p(e/h) \cdot p(h) + p(e/\sim h) \cdot p(\sim h)$

$$= p(h) + p(e/\sim h)(1 - p(h))$$



All swans are white

$p_0 = \frac{1}{N} = \frac{1}{2^M}$)

considering the first M swans

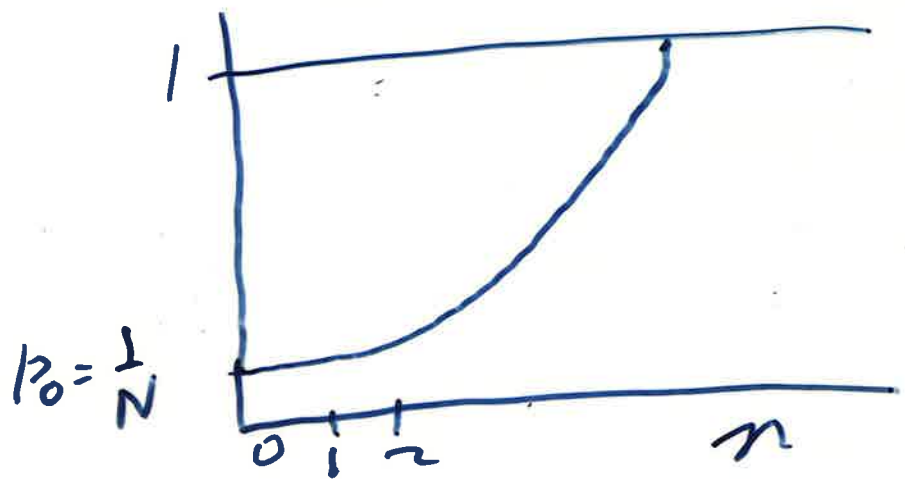
$\rightarrow 0$ as $M \to \infty$

Then $p_n = F_n \times \dots F_1 \times p_0 = 0$

This is Popper's argument.

Eliminative Induction

$p_n = \frac{1}{N-n}$, so $p_{N-1} = 1$



SOLUTIONS TO THE PROBLEM OF INDUCTION

contd.

(a) Uniformity of Nature

(b) Pragmatic justification

(c) Popper's solution

— we don't need induction!

Paradoxes of Confirmation (17)

1. The Raven Paradox
2. The Grue Paradox
3. Transitivity Paradox

See M. Hesse:
The Structure of Scientific Inference
1974

MILL'S METHODS OF EXPERIMENTAL INQUIRY

(A System of Logic, 1843)

1. Method of Agreement
2. Method of Difference
3. Joint Method of Agreement and Difference
4. Method of Residues
5. Method of Concomitant Variation

Method of Agreement

If two or more instances of the phenomenon under investigation have only one circumstance in common, this circumstance in which alone all the instances agree, is the cause of the given phenomenon

Method of Difference

If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring in the former; the circumstance in which alone the two instances differ is the cause, or an indispensable part of the cause, of the phenomenon.

Method of Residues

Subtract from any phenomenon such part as is known to be (by previous inductions) the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents.

Method of Concomitant Variation

Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner is connected with it through some fact of causation.

Problems with Mill's Methods

1. Irrelevant factors
2. Hidden factors
3. Plurality of Causes
4. Complexity of Causes.

Valid argument

Ex (1) I entered through the door or the window.

(2) I did not enter through the window.

∴ (3) I entered through the door

Extract the logical form of the argument.

X or Y

not Y

∴ X

If you accept the premisses then you are "compelled" to accept the conclusion not in virtue of the subject matter, but in virtue of the meanings of the logical particles OR, NOT...

The logical particles

connectives
and, or, if... then, not

quantifiers
all, some

copula 'is'.
Symbol of predication

N.B. In logic use inclusive sense of 'or'.
Not

contrast:
(1) This student is lazy or stupid
(2) I like music or poetry

So X or Y ≡ not(not X and not Y)
and X and Y ≡ not(not X or not Y)

Also All men are mortal
≡ not (Some men are not mortal)

and

Some men are mortal

≡ not (All men are not mortal)

Symbols

or	$\vee$	
and	$\wedge$	
not	$\sim$	or $\neg$
if --- then	$\supset$	or $\rightarrow$
All	$\forall$	
Some	$\exists$	

Ex All men are mortal

$\forall x (Mx \supset Mx)$

Some men are mortal

$\exists x (Mx \wedge Mx)$

Sound Argument

is a valid argument with true premisses.

so a sound argument delivers a true conclusion

N.B. This is not true of valid arguments per se.

A valid argument with false premisses may have a true or a false conclusion.

The same is true for invalid arguments with either true or false premisses.

So truth & falsehood
& conclusion in an
argument is like this:

Argument	Premisses: True	Premisses: False
Valid	T	T or F
Invalid	T or F	T or F

Logical Truth

A proposition which is true
in virtue of the meanings
of the logical particles

Ex (1) I am happy or I am not happy — X or (not X)

(2) All elephants are elephants
$\forall x (Ex \supset Ex)$

Logical Contradiction

is the negation of a logical truth, i.e. it is necessarily false.

Ex I am happy and I am not happy — X and (not X)

Four views on logical truth

1.) Psychological — laws of thought
2.) Platonic — objective meanings of the logical particles
3.) Very general laws of physics
4.) Instrumentalist conventions as to how we use the logical particles

Language and the World

LANGUAGE	Terms	Sentences
MENTAL REALM	concepts	propositions
PLATONIC WORLD	Ideas	Relations between Ideas
PHYSICAL WORLD	physical properties	states of affairs

The Meaning of a Term

(1) Extension

class of entities correctly classified as exemplifying the concept

(2) Intension

Collection of properties or attributes necessarily and essentially associated with the objects which comprise the extension

ex Man is a rational animal

A Statement is the affirmation of a proposition i.e. a claim that it is true

A Judgement is the rational assent to a proposition as being true (to be distinguished from mere belief)

An Analytic proposition is one which is true in virtue of the meaning of its constituent terms and/or the logical particles

Ex All Bachelors are unmarried

A Synthetic proposition is one which is not analytic

What are our grounds for believing a proposition to be true ?

a posteriori — Experience

a priori — Independently of experience

Kind of Knowledge		a priori	a posteriori
	analytic	✓	X
	Synthetic	?	✓

Source of Knowledge

The Synthetic a priori

Rationalists yes

Empiricists no

Is there a clear distinction between analytic and synthetic propositions in Science?

Ex: Caesar crossed the Rubicon

Ag melts at 960°C

Energy is conserved

The Duhem-Quine Thesis

Any particular proposition in the nexus of propositions constituting a scientific theory can be maintained in the light of any possible experience by making appropriate changes in other parts of the system.

Thus $H \wedge h_1 \wedge h_2 \wedge h_3 \cdots \Rightarrow O$

Does not (O) allow us to infer not (H)?

In fact

$\sim O \Rightarrow (\sim H) \vee (\sim h_1) \vee (\sim h_2) \cdots$

Ex1 $H \wedge h_1 \wedge h_2 \wedge h_3 \Rightarrow$ [illegible] $\wedge O$

H : whenever a thread is pulled with a force exceeding that which characterizes its tensile strength it will break

h_1 : no other forces are acting other than attacking a weight.

h_2 : force characteristic for this thread is 1 lb wt.

h_3 : wt. put on the thread is 2 lb.

O : Iron wt. of 2 lb was put on thread at space-time location γ and it did not break.

Crucial Experiments

$H_1 \Rightarrow e$

$H_2 \Rightarrow \sim e$

check whether e occurs

if it does: H_2 is false

if it does not: H_1 is false

So e is a crucial observation to decide between H_1 and H_2.

History of Logic

Aristotle — Categorical Syllogisms
↓
Predicate logic (quantification)

Stoics — Propositional Logic

Boole (Schröder) — Algebraic Logic (1847)

Frege — Predicate Logic (1879)
Logicism
(reduction of Mathematics to Logic)

Russell, Whitehead
Principia Mathematica
3 vols. 1910–1913

Gödel 1931 Incompleteness Theorem.

Mathematical Logic

Two Senses:

1. Logic exhibited as a formal axiomatic system

2. The logic required to do mathematics.

In the context of the logic required for science, we concentrate on 2 fragments of logic

syllogisms and propositional logic

The Categorical Syllogism

All humans are Mortal (major premiss)
All Athenians are human (minor premiss)

∴ All Athenians are Mortal (conclusion)

Extract logical form

All M's are P's
All S's are M's

∴ All S's are P's

M is the middle term.

we symbolize the argt. thus:

M — P
S — M

S — P

1st Figure

How can we generalize?

(1) There are 4 figures

$$\frac{P - M}{S - M} \quad \frac{}{S - P}$$ 2nd Figure

$$\frac{M - P}{M - S} \quad \frac{}{S - P}$$ 3rd Figure

$$\frac{P - M}{M - S} \quad \frac{}{S - P}$$ 4th Figure

But there are also
$4 \times 4 \times 4 = 64$ Moods

(giving 256 syllogisms in all)

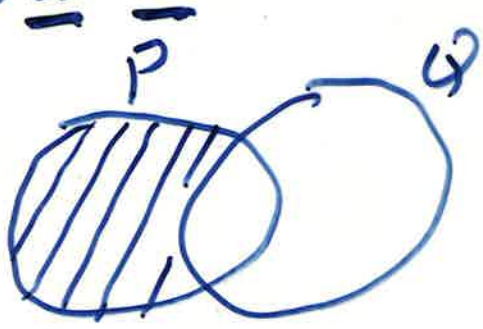
Moods

A All P are Q } Universal
E No P are Q }

I Some P are Q } Particular
O Some P are not Q }

So our first example is
A A A in the 1st Figure
Barbara

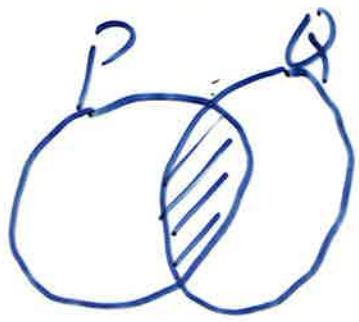
A



$P \cap \overline{Q} = 0$

$\forall x (Px \supset Qx)$

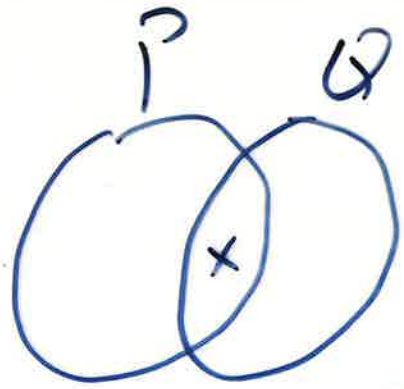
E



$P \cap Q = 0$

$\forall x (Px \supset \sim Qx)$

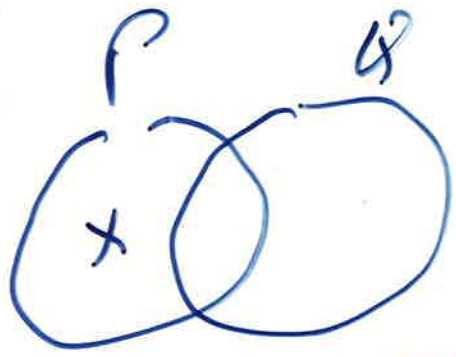
I



$P \cap Q \neq 0$

$\exists x (Px \wedge Qx)$

O

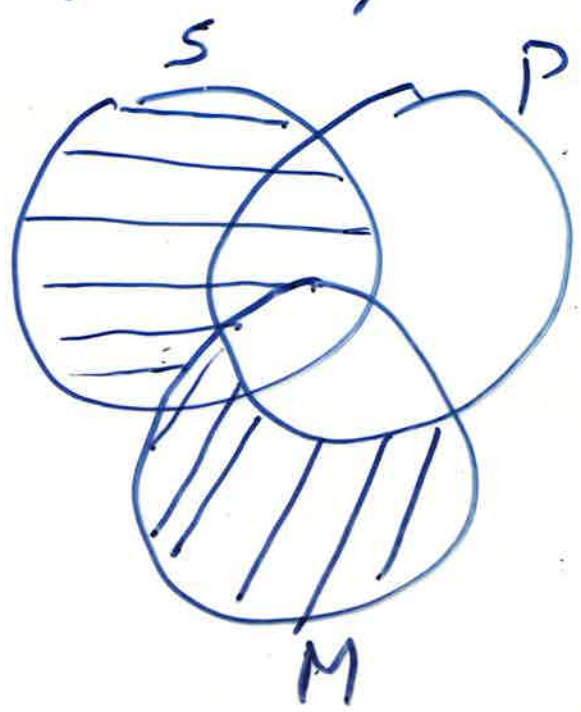


$P \cap \bar{Q} \neq 0$

$\exists x (Px \wedge \sim Qx)$

Examples

① A AA 1st Figure



All M are P
All S are M

All S are P

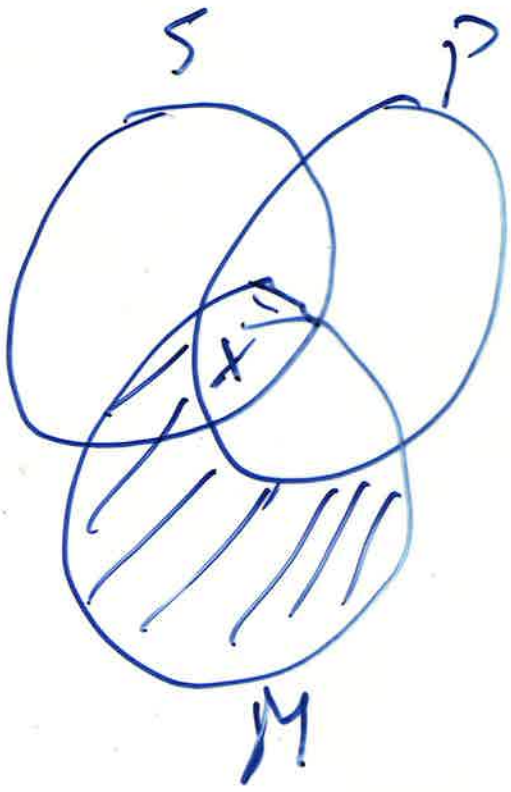
So Syllogism is valid.

(2) A I I 3rd Figure

Datisi

All M are P
Some M are S

Some S are P

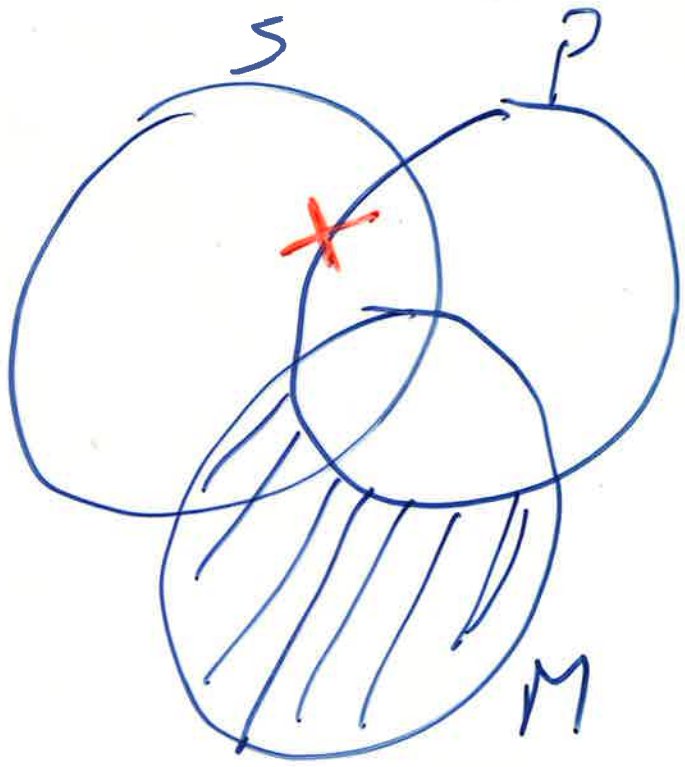


So Syllogism is Valid

(3) AOE 1st Figure (34)

All M are P
Some S are not M

All S are not P



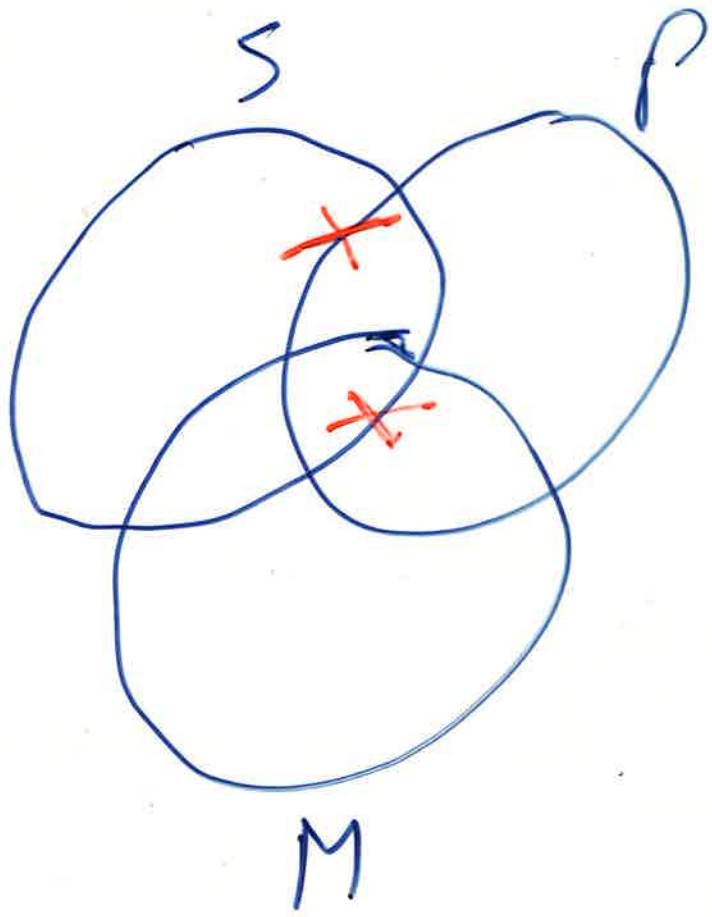
Invalid

(4) I 00 in 1st Figure

Some M are P

Some S are not M

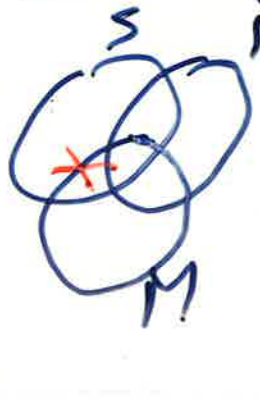
Some S are not P



Invalid

Undistributed Middle

conclusion



Propositional Logic

Truth Tables — or, and

p	q	p ∨ q	p ∧ q
T	T	T	T
F	F	F	F
T	F	T	F
F	T	T	F

not

p	~p
T	F
F	T

Tautology Logical truth specialized to propositional Logic

Ex. $p \vee (\sim p)$

p	$\sim p$	$p \vee (\sim p)$
T	F	T
F	T	T

Similarly $p \wedge (\sim p)$ is a logical contradiction

Implication statements

If p then q

How are p and q related?

1. logical connection
2. Causal connection
3. Definitional connection
4. Decisional connection

What about
If chelsea wins the cup then
I am a monkey's uncle ?

Analyse $p \supset q$ as

$$\sim(p \wedge (\sim q))$$
$$\equiv (\sim p) \vee q$$

or in terms of truth tables

p	q	$p \supset q$
T	F	F
F	F	T
F	T	T
T	T	T

Notice

If p is false then $p \supset q$ is always true.

Ex If a circle is square then God exists is a true proposition!

But also

If a circle is square then God does not exist!

Modus ponens

$p \supset q$

p

$\therefore q$

Modus tollens

$p \supset q$

$\sim q$

$\therefore \sim p$

The fallacy of affirming the consequent

$$\frac{p \supset q \quad q}{\therefore p}$$

Invalid argument

Deduction Theorem

$p \vdash q$ derivability

$p \models q$ logical consequence

$\models q$ q is a tautology

① $p \vdash q$ iff $p \models q$ soundness and completeness

② $p \models q$ iff $\models (p \supset q)$

(Semantic Version of Deduction Theorem)

Levels of factual knowledge

0 Subjective experience

1 Singular statements about observable things of events

2. Regularities displayed by ①

3. Exact experimental laws

4. Scientific Theories

Falsification

All swans are white

$\forall x (S(x) \supset W(x))$

$\equiv \sim \exists x \sim (S(x) \supset W(x))$

$\equiv \sim \exists x \sim (\sim S(x) \vee W(x))$

$\equiv \sim \exists x (S(x) \wedge (\sim W(x)))$

This is refuted by

$\exists x (S(x) \wedge (\sim W(x)))$

i.e. by Some swans are not white

Singular Predictive Implication (SPI)

$S(k) \supset W(k) \equiv \sim (S(k)) \vee W(k)$

Potential falsifier $\sim$ (SPI)

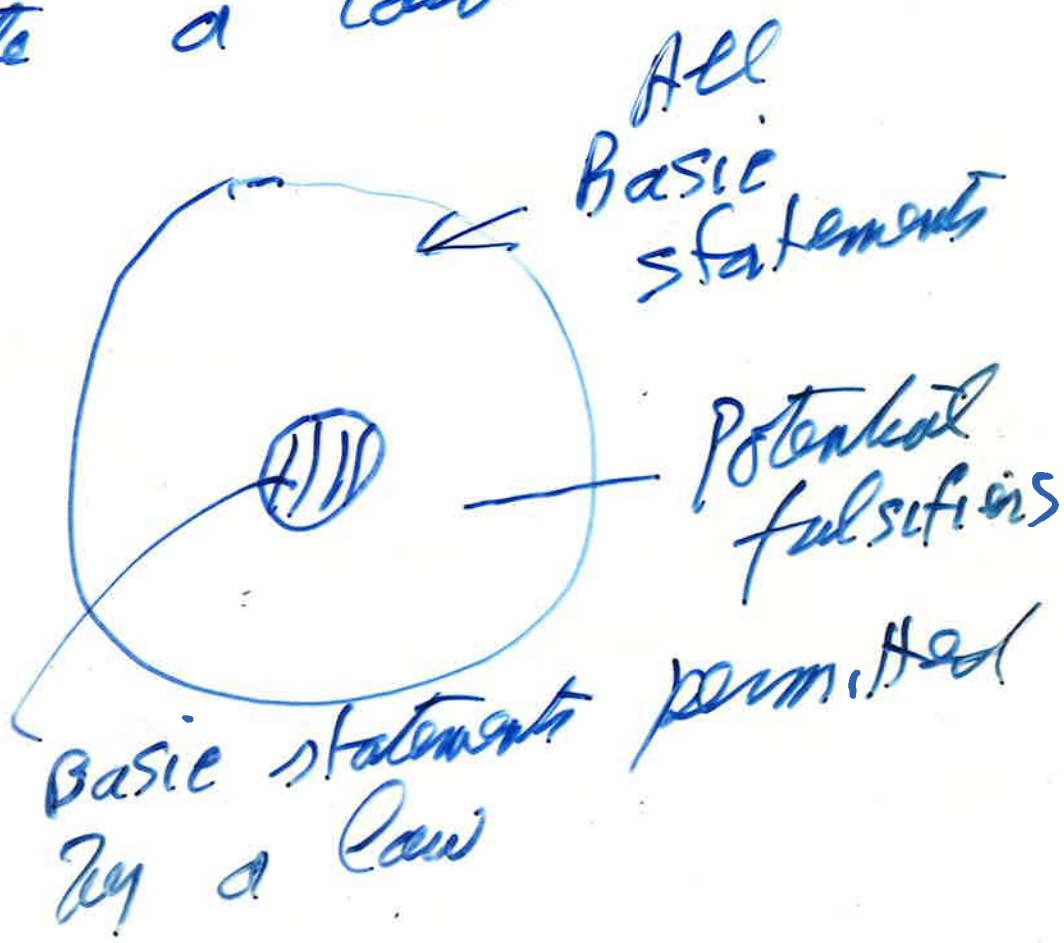
$\equiv S(k) \wedge (\sim W(k))$

Basic statement

Singular existential statement which is of right logical form to refute a universal law.

Potential falsifier

Basic statement which falsifies / refute a law



For Popper a theory should be:

	Feature	Reason
a)	Testable	Scientific
b)	lead to novel predictions	corroborable
c)	be corroborated	increase in verisimilitude

Popper schema

$$P \rightarrow TT \rightarrow EE \rightarrow P'$$

Problem — Tentative Theory — Error elimination — new problem

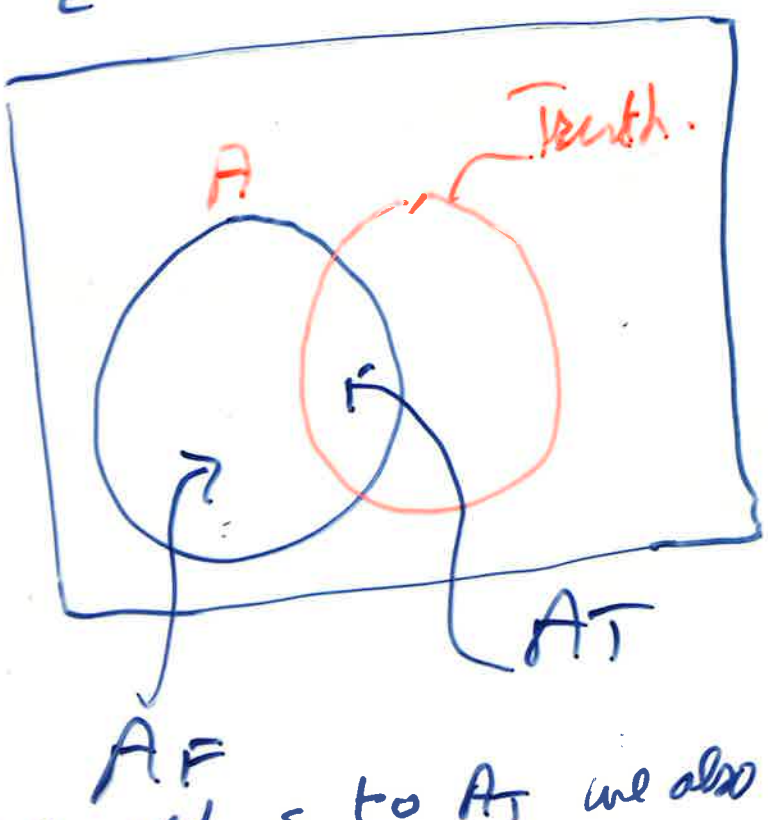
Verisimilitude

$$\approx m(\text{Truth Content}) - m(\text{Falsity Content})$$

So $V(A) = m(A_T) - m(A_F)$

$A_T = \{\text{True consequences of } A\}$

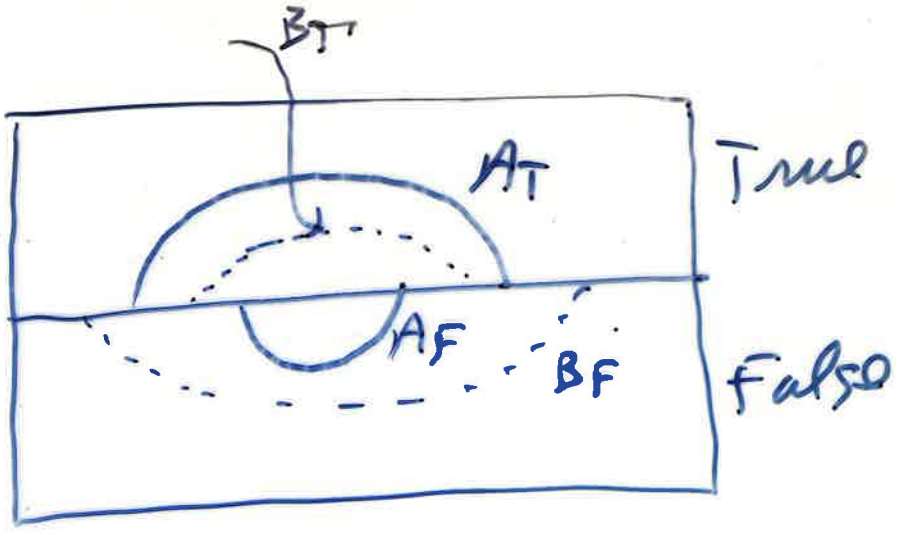
$A_F = \{\text{False consequences of } A\}$



r is any false consequence of A.

But if we add s to A_T, we also add $s \wedge f$ to A_F
and if we take away s' from A_F, we also take away $r \wedge s'$ from A_T

9f



Then $V(A) > V(B)$

But this situation is not possible

Ex A: It is now between 9.45 & 9.48
9.40 & 9.48
B: - - - - - -

Truth: It is now 9.50.

A_T all sentences of form: It is now between x & y where $x < 9.45$, $y > 9.50$

Similarly for B_T where $x < 9.40$, $y > 9.50$

Clearly $B_T \subset A_T$, but $A_F \not\subset B_F$

Because A itself is a member of A_F which is not in B_F!

Consider 2 astronomical theories:

P = nº of planets

D = nº of days in the week.

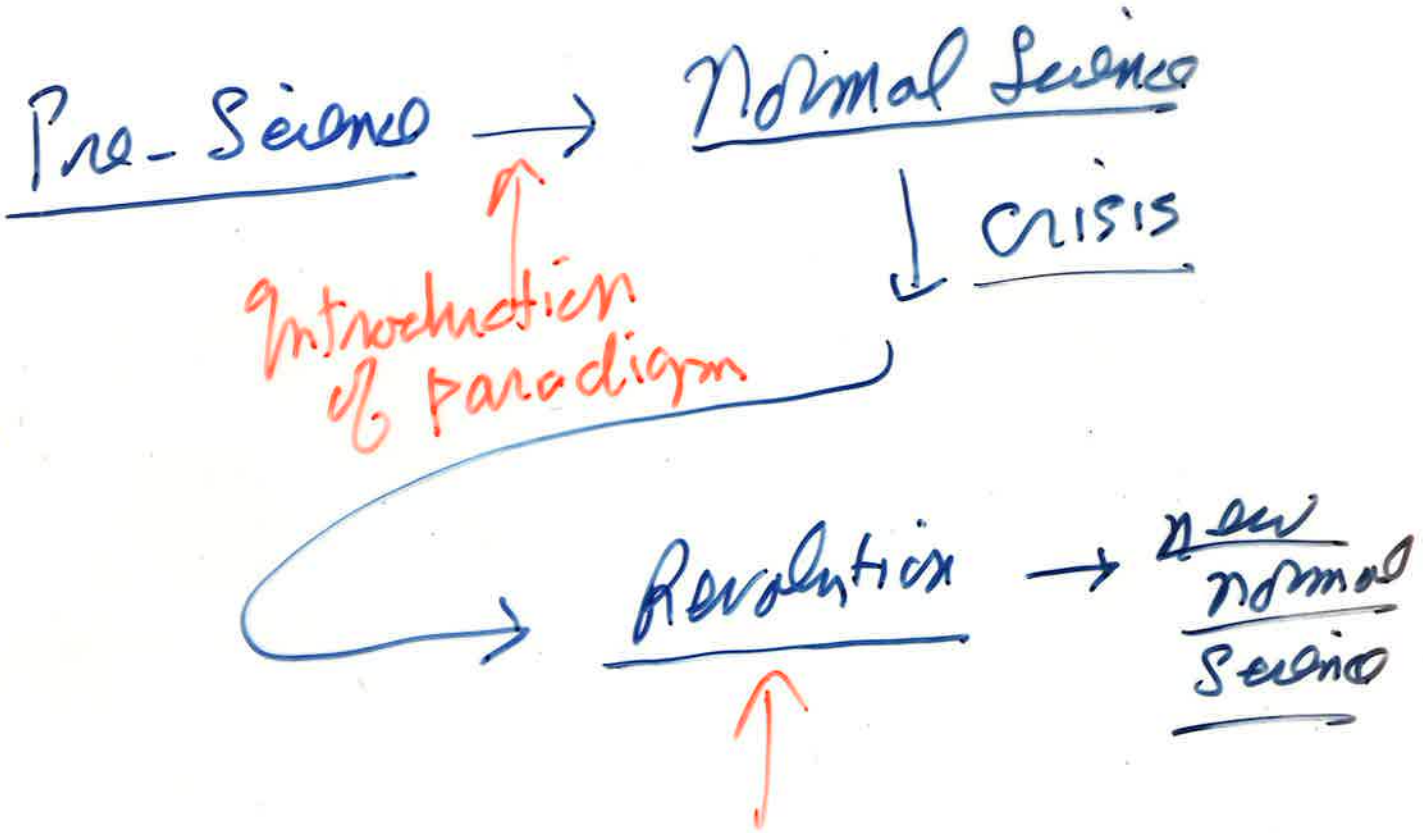
	P	D	P+D
Truth	9	7	16
A	11	5	16
B	9	5	14

Is V(B) > V(A) ?

yes on basis of P & D

no on basis of P, D & P+D

KUHN



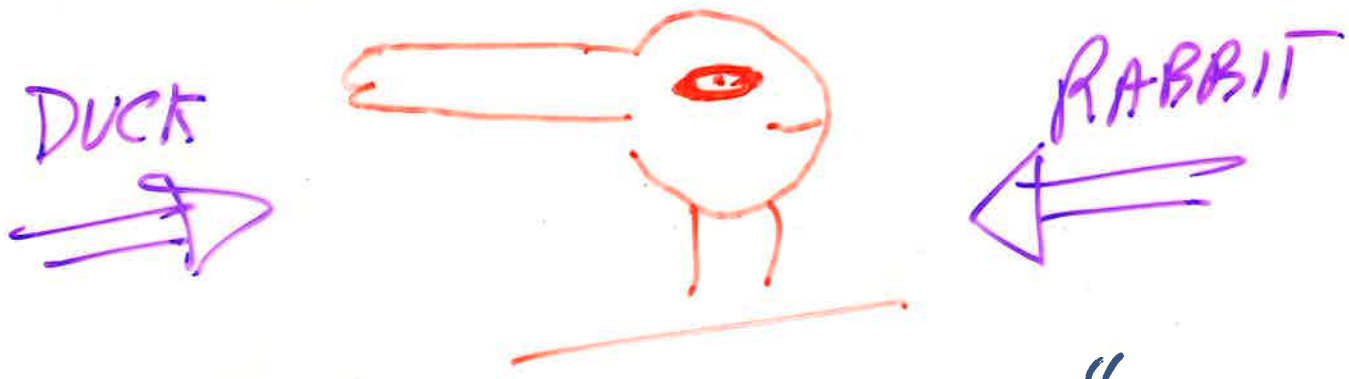
Senses of Paradigm

1. Sociological
2. Metaphysical
3. Artefact paradigm

Incommensurable World Views

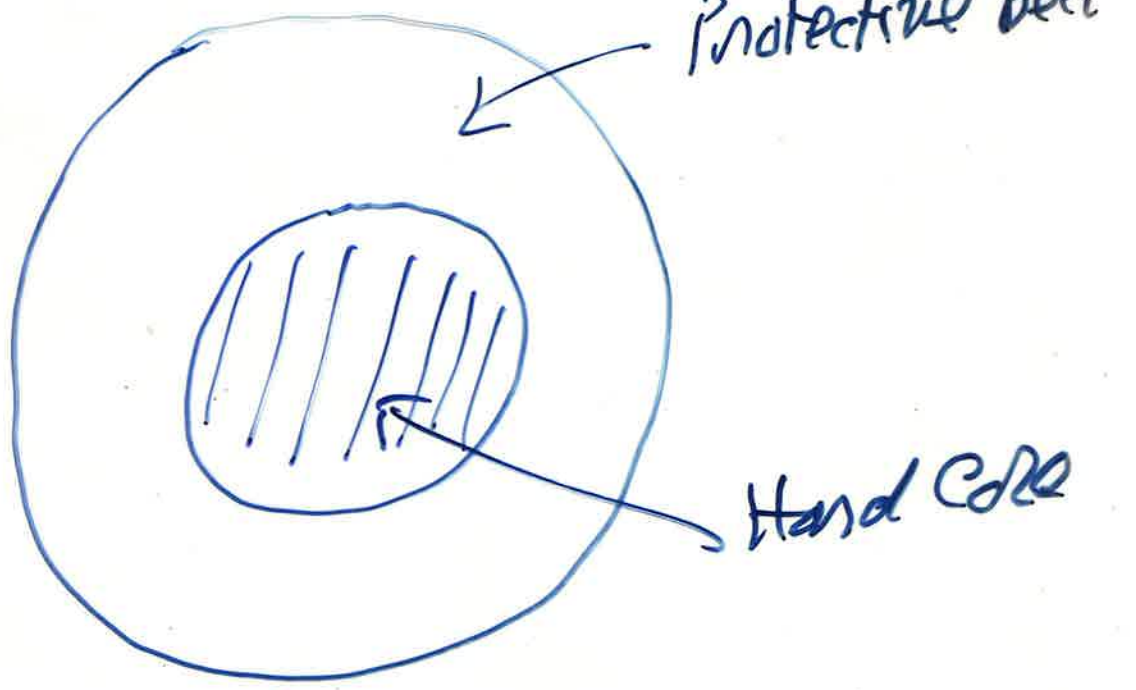
1. Different ontology.

2. Different sorts of question are meaningful and legitimate



Does "Rabbits eat lettuce" contradict "Ducks do not eat lettuce"?

Methodology of Scientific Research Programmes (MSRP)



Positive Heuristic

A "research policy" for articulating the protective belt and so developing a succession of theories in the Programme.

Negative Heuristic Do not change the hard core.

FEYERABEND

PLURALISM

1. Methodological
2. Theoretical
3. Ideological